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FINAL SUBMITTAL

EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS PROGRAM  
FULDA MILITARY COMMUNITY  
GERMANY

Prepared for  
DEPARTMENT OF THE ARMY  
EUROPE DIVISION, CORPS OF ENGINEERS  
FRANKFURT, GERMANY

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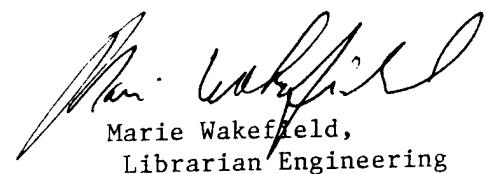


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SECTION A.0  
EXECUTIVE SUMMARY

A.1 INTRODUCTION OF PROJECT

This Executive Summary outlines the results of all work for the Energy Engineering Analysis Program (EEAP), Fulda Military Community, Germany. This work was authorized under contract number DACA 90-82-C-0204 with the U.S. Army Corps of Engineers, Europe Division, Frankfurt A/M, Germany.

The primary purpose of the Energy Engineering Analysis Program was to develop Energy Conservation Investment Program (ECIP) projects that comply with the objectives set forth in the Army Facilities Energy Plan.

The work was performed in three phases: Phase I consisted of data gathering and inspection of facilities culminating in a data report; Phase II included energy data analysis, evaluation of the technical and economic feasibility of energy conservation opportunities, and completion of the front pages of DD Forms 1391; Phase III included preparation and completion of DD Forms 1391, including detailed justifications and project development brochures (PDB-I's).

The following increments of work were authorized in the scope of services:

- Increment A: Buildings and processes
- Increment B: Utilities and energy distribution systems, Energy Monitoring and Control Systems (EMCS), and use of waste fuels in existing energy plants.
- Increment F: Facilities Engineer funding authority energy conservation projects.

- Increment G: Energy conservation projects found viable but that do not meet ECIP criteria.

## A.2 EXISTING ENERGY SITUATION

### A.2.1 Baseline FY75 Energy Consumption

Total USMC Fulda energy consumption by source for FY75 has been reported as follows:

Electricity	$136,847 \times 10^6$ BTU
Coal	$143,420 \times 10^6$ BTU
No. 2 Fuel Oil	$185,716 \times 10^6$ BTU
Natural Gas	$7,038 \times 10^6$ BTU
Liquid Propane Gas	$3,762 \times 10^6$ BTU
TOTAL	$476,783 \times 10^6$ BTU

### A.2.2 Present Annual Energy Consumption

Total energy consumption at USMC Fulda in FY82 of non-transportation energy sources was 552,642 million BTU. A breakdown in FY82 energy consumption and cost by source is shown in the following table:

ENERGY SOURCE	QUANTITY	MBTU	AVERAGE COST/MBTU 1/ DOLLARS (DM 2.40=\$1)
Natural Gas	752,750 Cubic Meters	28,709	5.34
Liquid Propane Gas	95,960 Gallons	9,306	7.52
No. 2 Fuel Oil	1,429,000 Gallons	195,180	10.02
Coal, Bituminous	1,430 Metric Tons	41,110	3.49
Coal, Anthracite	3,314 Metric Tons	98,460	6.28
Electricity	15,507 MWH	179,877	5.71

1/ FY82, 4th quarter

The relative consumption by energy source is shown graphically in Figure A-1.

The breakdown in source energy consumption for FY82 by GY area is shown in Table A-1.

#### A.2.3 Energy Consumption by End Use and Building Function

The breakdown in source energy consumption by end use is shown in Table A-2. The breakdown in source energy consumption facility function is shown in Table A-3. The relative consumption by energy use and facility function is shown graphically in Figure A-2.

#### A.2.4 Typical Building Energy Consumption

A breakdown in estimated FY82 energy consumption by end use (lighting, space heating, domestic hot water heating and process loads) for typical buildings representative of all facilities at USMC Fulda is shown in Table A-11.

### A.3. ENERGY CONSERVATION OPPORTUNITIES DEVELOPED

#### A.3.1 Energy Conservation Opportunities Investigated

A summary of all potential energy conservation opportunities (ECO's) considered for implementation at USMC Fulda is presented in Table A-4. A matrix of reasons for eliminating certain ECO's from further consideration is included in Table A-4.

### A.3.2 ECIP Projects Developed

During the Phase II effort, documentation was developed for twenty-five ECO's, including many that did not meet the ECIP \$200,000 funding minimum. A set of project combinations to attain the ECIP funding minimum were proposed and accepted at the Phase II presentation at USMC Fulda. The following paragraphs describe these recommended ECIP project combinations.

1. ECIP: Heating Plant Piping Insulation and Waste Heat Recovery includes the following retrofit measures:
  - a. Repair leaks and replace insulation in central plant distribution piping.
  - b. Install and repair insulation within heating plants on boilers, vessels, and tanks.
  - c. Install boiler flue gas-combustion air preheater.
  - d. Install continuous boiler blow-down controls with waste heat recovery.
  - e. Install oxygen trim boiler combustion controls.
2. ECIP: Boiler Plant Upgrade for Family Housing include the following measures:
  - a. Install and repair insulation within heating plants on boilers, vessels, tanks, and piping.
  - b. Replace existing hand-stoked boilers with automatic feed boilers in Downs Family Housing Area, GY733.
  - c. Isolate off-line boilers.
3. ECIP: Domestic Hot Water Heating Energy Conservation includes the following measures:
  - a. Install flow restriction devices on faucets and shower heads.

- b. Reduce domestic hot water temperatures.
- c. Curtail availability of domestic hot water with time scheduled control.
- d. Install hot drain heat exchangers in laundries and kitchens.
- e. Provide waste heat recovery from laundry dryers with rotary wheel type heat exchangers.

4. ECIP: Building Heating Controls Upgrade includes the following measures:

- a. Install night and weekend temperature setback controls and thermostatic radiator control valves.
- b. Install outside air temperature reset of heating hot water supply.
- c. Provide separate source of make-up air for kitchen exhaust hoods.
- d. Install unit heater economizers in Building 7211.

5. ECIP: Weatherize MCA Facilities includes the following measures:

- a. Weatherstrip and caulk doors and windows.
- b. Install roof insulation.
- c. Replace single pane windows with dual glazed windows.

#### A.3.3 Other Energy Conservation Projects Developed

All Increment F projects identified during Phase II have been combined into ECIP projects, except those Increment F combinations that fall below the \$200,000 minimum funding requirement. No projects developed in this study fall into the Increment G category. Recommended energy conservation projects that fall within the \$200,000 funding authority of the Facilities Engineer are summarized in Table A-5.

Complete programming documentation also was prepared for the following project combinations that did not meet the minimum level for ECIP funding:

1. Building Heating Controls Upgrade for Family Housing includes the following measures:
  - a. Install night temperature setback controls and thermostatic radiator control valves.
  - b. Install outside air temperature reset of heating hot water supply.
2. Domestic Hot Water Heating Energy Conservation for Family Housing includes the following measures:
  - a. Install flow restricting shower heads and lavatory fixtures.
  - b. Reduce domestic hot water temperature settings.
  - c. Curtail availability of domestic hot water with time scheduled control.
3. Lighting System Improvements includes the following measures:
  - a. Replace incandescent fixtures with energy-saving fluorescent fixtures.
  - b. Install time switch control of lighting panels.
4. Weatherize Family Housing Facilities includes the following measure:
  - a. Install roof or ceiling insulation.

#### A.3.4 Recommended Policy and Operations Changes

The following policy changes and new policies are recommended for implementation by the military community:

- Laundry Dryer Usage: Laundry dryers in family housing dwellings are electric clothes dryers. A considerable electric demand charge reduction could be realized if these dryers were not used during peak demand periods. It is recommended that a directive be prepared by appropriate authority prohibiting their usage during these periods.
- Barracks Lighting During Non-Occupied Periods: Field investigations for this study indicate that many lights in unoccupied rooms were left on. It is recommended that a directive be prepared by appropriate authority to require that lighting circuits be turned off at panelboards for each section of barracks buildings during schedules times of non-occupancy. (Exceptions should be allowed for personnel that must remain in their rooms for authorized reasons).

The following changes in standard operating procedures are recommended for implementation by the military community:

- Turning off Services to Barracks During Field Rotations: It is recommended that all utility services, including lighting, electrical and heating, be turned off in sections of barracks buildings normally occupied by a company that is assigned to field training or BOP service. Personnel left behind for authorized reasons should be temporarily assigned to another room in an (currently) occupied section of the barracks during these periods. (Heating systems should be maintained at a low



level of heating during freezing weather to prevent freezing of pipes, etc.)

- Group Relamping: It is recommended that a group relamping program with relamping targeted for 70 percent of rated lamp life be initiated. (See Section 11.0 for details.)
- Boiler Plant Operations: No revisions to present boiler operations are recommended. Considering the age and condition of many boiler plants within the community operations procedures currently in effect provide near-optimal service.

The following suggestion concerns an issue outside the authority of the military community: Coal shipped from the United States comes to Europe with a relatively high content of inert material. The quality of this coal is considerably below that normally available in the United States. The command should consider:

- Revising the specification for this coal, or
- Providing a central cleaning facility at a transshipment point either in the United States or in Europe, or
- Allowing local domestic (foreign) suppliers to submit competitive bids for supplying coal.

#### A.4 ENERGY AND COST SAVINGS

##### A.4.1 Energy Consumption Forecast After Total Project Implementation

Monthly energy use profiles for FY82 and projected after implementation of all recommended projects are shown graphically in Figure A-3. Projected energy consumption by end use with conservation measures implemented is summarized in Table A-6. Projected energy consumption by facility function with conservation measures implemented is summarized

in Table A-7. These projections represent the levels below which the military community realistically could not be expected to function.

#### A.4.2 Projected Utility Costs

Projected utility costs for USMC Fulda are summarized in Table A-8.

#### A.4.3 Schedule of ECIP Projects

A summary of ECIP project data for USMC Fulda is provided in Table A-9.

### A.5 SUMMARY AND CONCLUSIONS

This EEAP study for USMC Fulda has provided the following data and deliverables for use by the community in preparing its energy conservation plan and attaining its energy conservation goals:

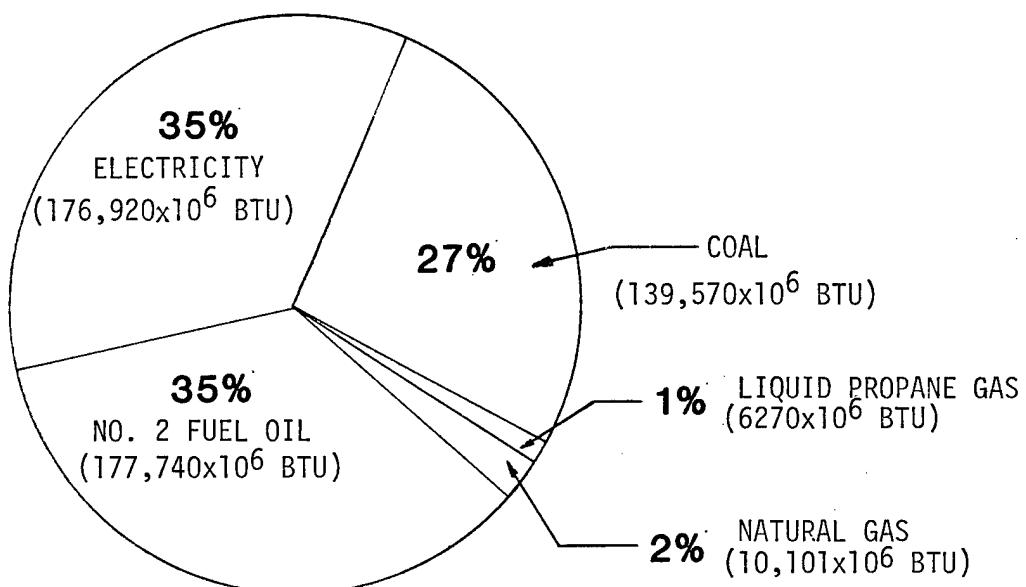
- Historical energy consumption of all USMC Fulda GY areas.
- Energy consumption by each facility function and end use.
- Energy simulations of 12 typical buildings using the B.L.A.S.T. computer program.
- Documentation for ECO's that should not be accomplished because of insufficient economics.
- Complete DD Forms 1391 and PDB-1's for five ECIP projects totaling \$3,049,300 in construction cost.
- Complete DD Forms 1391 and PDB-1's for four Increment F projects totaling \$478,600 in construction cost.

Implementation of all energy conservation projects recommended in this EEAP Study as well as retrofits recently accomplished by the community would result in an overall energy savings of 46 percent<sup>1/</sup> from FY75 consumption (see Table A-10). This amount exceeds the savings goal for FY85 of 20 percent.

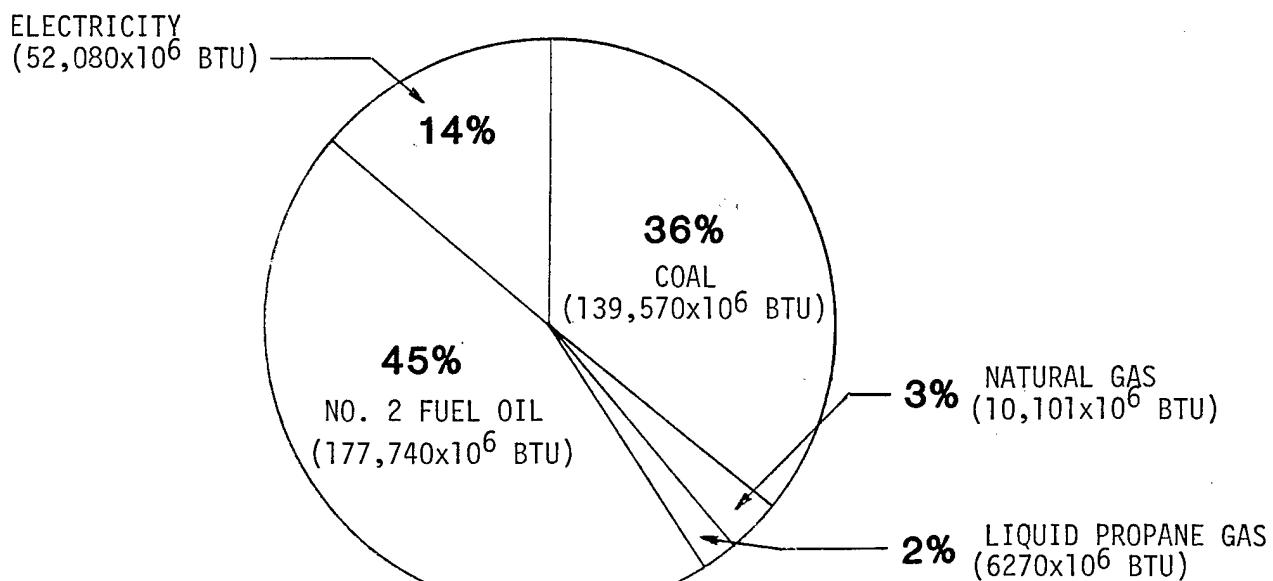
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<sup>1/</sup>Per square feet of active facilities.

FACILITIES ENERGY CONSUMPTION BY SOURCE  
USMC FULDA



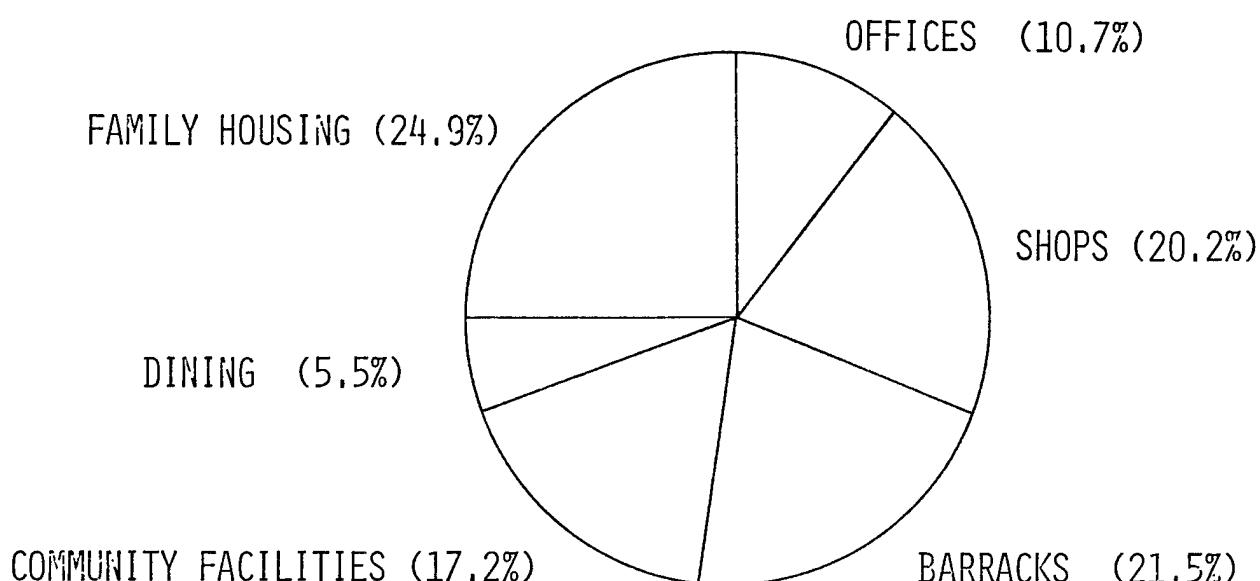
a. FY 82 FACILITIES ENERGY CONSUMPTION  
(ELECTRICITY CONVERTED USING 11,600 BTU/KWH)



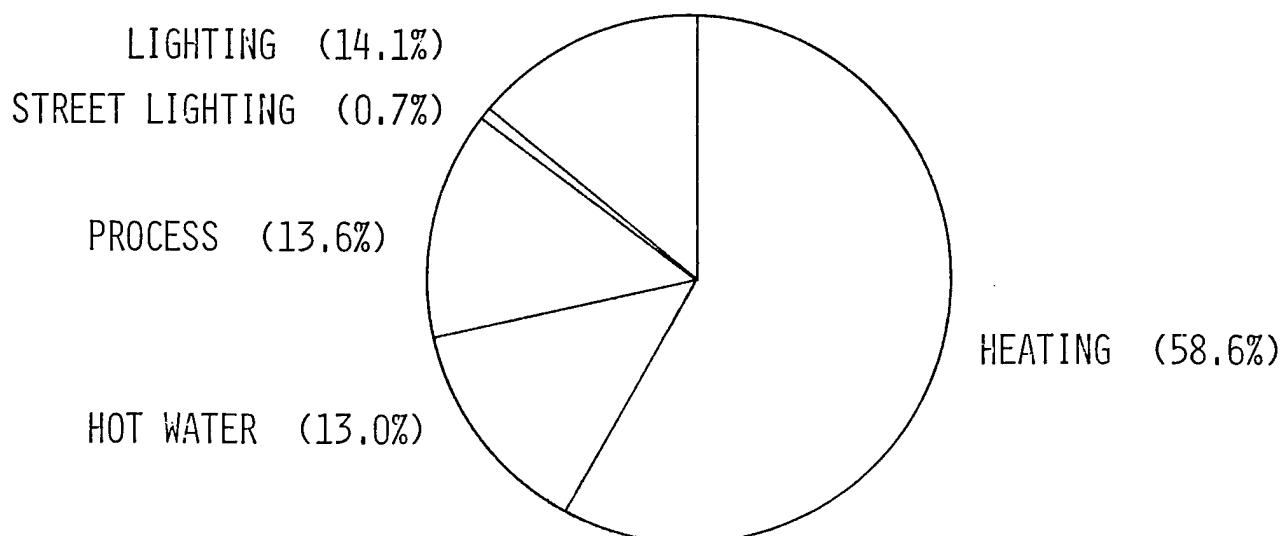
b. FY 82 FACILITIES ENERGY CONSUMPTION  
(ELECTRICITY CONVERTED USING 3,413 BTU/KWH)

FIGURE A-1

## FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION AND END-USE, USMC FULDA



FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION



FY82 ENERGY CONSUMPTION BY END-USE

**FIGURE A-2**

# SUMMARY: MONTHLY ENERGY USE PROFILES FOR FY82 AND PROJECTED ENERGY CONSUMPTION

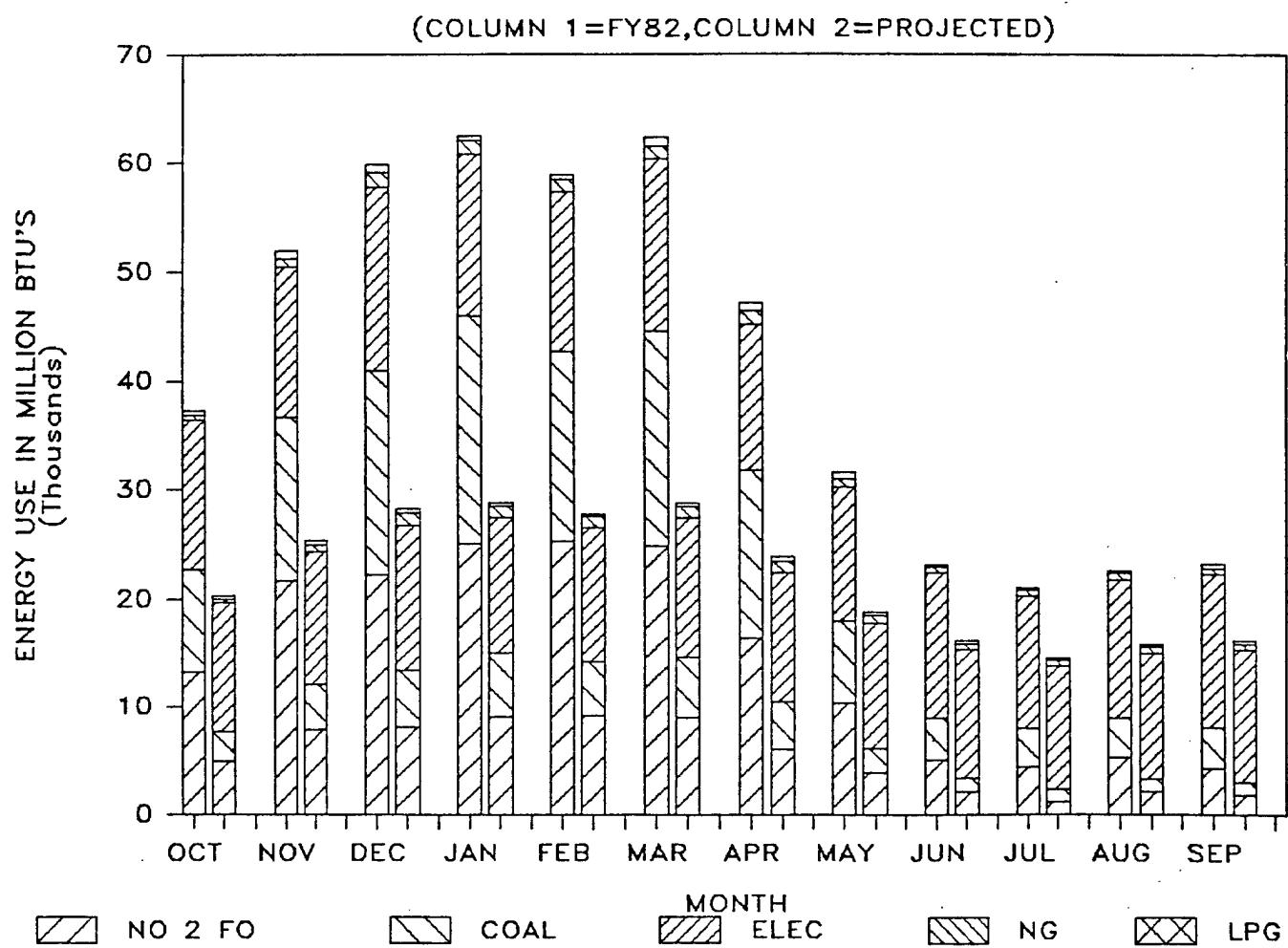


FIGURE A-3

**SUMMARY OF EEAP ANALYSIS RESULTS FOR USMC FULDA**

GY AREA	DESCRIPTION	FY82 ENERGY USAGE			ESTIMATED FUTURE ENERGY USAGE <sup>1/</sup>			BTU/SF PER YEAR	TOTAL GROSS SF	BTU/YR
		10 <sup>6</sup> BTU/YR	GROSS SF	BTU/SF PER YEAR	EXISTING FACILITY 10 <sup>6</sup> BTU/YR	NEW CONSTRUCTION 10 <sup>6</sup> BTU/YR				
A20	TAUFSTEIN RR STATION	1,920	1,858	1,033	822	-	-	1,858	442	
A54	BOP INDIA	3,580	11,221	319	1,979	-	-	11,221	176	
A55	BOP ROMEO	2,840	5,598	507	1,712	-	-	5,598	306	
A57	BOP ALPHA	3,790	10,107	375	2,686	-	-	10,107	266	
A66	FSTS HERBSTEIN	820	34,933	24	545	-	-	34,933	16	
249	DOWN BARRACKS	164,840	958,672	172	89,909	5,118	1,131,445	84		
264	ENGINEER AREA - BAD HERSFELD	12,511	66,068	189	9,117	-	-	66,068	138	
266	ENGINEER AREA - FULDA	16,950	275,566	62	9,637	-	-	275,566	35	
406	MCFEEETERS BARRACKS	96,660	431,100	224	45,884	400	434,066	107		
663	SICKELS AAF - FULDA	23,150	138,999	167	22,075	1,500	145,995	161		
726	MCFEEETERS VILLAGE	43,340	301,288	144	27,345	-	305,288	90		
733	DOWNS FAMILY HOUSING	100,840	401,730	251	55,166	-	430,200	128		
852	CLASS IIII DEPOT - BAD HERSFELD	300	588	561	300	-	-	588	510	
853	RIFLE RANGE - BAD HERSFELD	-0-	15,153	-0-	-0-	-	-	26,721	-0-	
854	JOHANNESBERG AAF - BAD HERSFELD	1,920	5,241	366	1,157	-	-	5,241	221	
913	CLASS V STORAGE - BIMBACH	2,850	23,480	121	2,269	-	-	35,048	65	
931	FINKENBERG TAC DEF SITE	16,670	11,084	1,504	7,432	-	-	11,084	671	
936	SEMELBERG TAC DEF SITE	17,590	15,994	1,100	10,118	-	-	15,994	633	
-		510,601	2,708,680	190	288,156	7,018	2,947,021	100		
	LEASED HOUSING	42,041	317,677	132	42,041	-	317,677	132		
	GRAND TOTAL - USMC FULDA	552,642	3,026,357	182,6	330,197	7,018	3,264,698	103		

<sup>1/</sup> INCLUDES RECOMMENDED AND FUNDED ENERGY SAVING PROJECTS AND PLANNED NEW CONSTRUCTION THROUGH FY85.

**TABLE A-1**

SUMMARY OF FY82 ENERGY CONSUMPTION BY END USE: USMC FULDA<sup>1/</sup>

ENERGY USAGE CATEGORY	ENERGY USE ESTIMATE FOR FY82 (MILLION BTU PER YEAR)					TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	ELECTRICITY	
Space Heating	103,799	156,698	3,534	2,186	33,141	299,358
Domestic Hot Water	35,771	18,291	2,689	3,845	5,957	66,552
Process Consumption	-0-	2,751	3,879	239	62,609	69,478
Lighting-Inside	-0-	-0-	-0-	-0-	71,748	71,748
Lighting-Outside / Street	-0-	-0-	-0-	-0-	3,465	3,465
<b>TOTAL ENERGY USAGE FY82</b>	<b>139,570</b>	<b>177,740</b>	<b>10,102</b>	<b>6,270</b>	<b>176,920</b>	<b>510,601</b>

<sup>1/</sup> Leased housing is not included.

TABLE A-2

SUMMARY OF FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION: USMC FULDA<sup>1/</sup>

BUILDING FUNCTION	ENERGY USE ESTIMATE FOR FY82 (MILLION BTU PER YEAR)					TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	ELECTRICITY	
Offices and Administration	26,595	13,702	-0-	1,047	12,697	54,041
Shops and Maintenance	9,885	67,758	-0-	-0-	24,757	102,400
Barracks and Quarters	38,132	17,954	7,076	5,223	40,596	108,981
Community Facilities	2,326	46,278	-0-	-0-	38,734	87,336
Dining Facilities and Clubs	-0-	12,684	382	-0-	15,052	28,118
Family Housing	62,633	19,364	2,644	-0-	41,619	126,260
Utilities - Street Lighting	-0-	-0-	-0-	-0-	3,465	3,465
TOTAL ENERGY USAGE FY82	139,571	177,740	10,102	6,270	176,920	510,601

1/ Leased housing is not included.

TABLE A-3

SUMMARY OF ECO EVALUATIONS FOR USMC FUJDA

DESIGNATION	DESCRIPTION OF ECO	ECIP <sup>1</sup> /	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
1A	Reduce Equipment Operating Hours							•
2A	Reduce Load Due to Ventilation			•				
3A	Night Set-Back (& Weekends) Thermostatic Controls	•						
3B	Install Dead-Band Thermostats		•					
4A	Reduce DHW Temperatures	•						
4B	Install Flow Restriction Devices	•						
4C	Install Self-Closing Valves		•					
5A	Isolate Off-Line Boilers	•						
6A	Segregate Areas @ No or Lower Conditioning Levels		•					
7A	Reduce Lighting Levels (Delamp, Relocate)		•					
8A	Reduce Lighting Usage (Photo Cells, Task Switching, Time Clocks)			•				
9A	Use Natural Light (Sky Lights & Clerestory Windows)				•			
10A	Reduce Lamp Wattages			•				
10B	Remove/Replace Diffusers and/or Lenses				•			
10C	Improve Room Wall & Ceiling Reflectance			•				
10D	Group Relamping Programs				•			
11A	Install More Efficient Lamps				•			
12A	Install More Efficient Lighting Fixtures			•				
13A	Install More Efficient Ballasts				•			
14A	Install Wall Insulation				•			
14B	Install New Insulated Maintenance Bay Doors				•			
15A	Install Dual Glazed Windows			•				
16A	Install Roof or Ceiling Insulation			•				

<sup>1</sup>/ Denotes that ECO is included as part of an ECIP project.

**TABLE A-4**

SUMMARY OF ECO EVALUATIONS FOR USMC FULDA

DESIGNATION	DESCRIPTION OF ECO	ECIP <sup>1/</sup>	INCREMENT 'G' 'F'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
17A	Install Floor Insulation					•		
18A	Caulk and Weather-Strip Around Doors and Windows	•						
18B	Provide Air Curtains on Frequently Used Doors		•					
18C	Install Building Vestibules		•					
19A	Remove (Maintain) Resistances to Air Flow		•					
20A	Reduce Flow Resistance in Liquid Pumping Systems			•				
21A	Repair &/or Replace Boiler Plant Piping & Insulation	•						
21B	Insulate Valves in Boiler Plants		•					
21C	Repair, Replace, Install Boiler & Vessel Insulation	•						
22A	Fix Leaks & Insul. in Central Plant Distrib. Systems	•						
23A	Replace Steam Traps			•				
24A	Convert Heating Systems to More Efficient Media			•				
25A	Install Thermostatic Radiator Control Valves	•						
26A	Outside Air Temp Resets on HW Heating	•						
26B	Provide Zone Controls for Buildings		•					
27A	Install Economizers on AHU Systems	•						
28A	Use Separate Make-Up Air for Exhaust Hoods	•						
29A&B	Use Radiant Heating in High Infiltration Areas			•				
30A	Reduce Energy Consumption in Double Duct Systems			•				
31A	Replace Existing with Modular or Auto-Feed Boilers	•						
32A	Reclaim Heat from Flue Gasses to Preheat Comb. Air	•						
33A	Install Flue Gas Economizers (Preheat Feed Water)			•				
33B	Install Oxygen Trim Boiler Combustion Controls	•						

1/ Denotes that ECO is included as part of an ECIP project.

**TABLE A-4**

SUMMARY OF ECO EVALUATIONS FOR USMC FULDA

DESIGNATION	DESCRIPTION OF ECO	ECIP1/	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
33C	Replace Inefficient with More Efficient Burners				•			
33D	Install Turbulators in Fire-Tube Boilers			•				
33E	Replace Steam with Air-Atomizing Burners		•					
34A	Install Automatic Boiler Blow-Down Controls	•						
34B	Recover Heat from Boiler Blow-Down	•						
35A	Utilization of Heat Reclamation Systems							
36A	Insulate DHW Distribution Piping within Buildings	•						
37A	Heat Recovery (Hot Gas Exch.) from Laundry Dryers	•						
37B	Hot Drain Exchangers for Laundries & Kitchens	•						
37C	Hot Condensate Heat Recovery (Flash Steam)	•						
38A	Decentralize DHW Service - Non-Heating Season	•	•					
39A	Solar DHW Heating Systems	•						
40A	Curtail Availability of DHW	•						
41A	Reduce Energy Consumption of Equip. & Machines	•						
42A	Reduce Peak (Electrical Loads)	•						
43A	Utilize More Efficient Transformers	•						
44A	Replace Oversized Motors	•						
45A	Correct Power Factor	•						
46A	Energy Management & Control System(s) (EMCS)	•						
46B	Power Line Carrier System	•						
47A	Reschedule/Consolidate Utilization of Facilities	•						
48A	Connect to District Heating to Purchase Energy	•						
49A	Install Family Housing Unit Energy Metering	•						
50A	Electrical Service for GY 853 Bad Hersfeld	•						

1/ Denotes that ECO is included as part of an ECIP project.

**TABLE A-4**

**SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC FULDA**

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10 <sup>6</sup> BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	MATERIAL COST	COST TO IMPLEMENT		TOTAL COST (US \$)	SIR
						TRADE	MAN-HOURS		
RESET DHW TEMPERATURE ON EQUIPMENT	22 FAMILY HOUSING BUILDINGS	6,292	\$42,164	567,618	\$ -0-	PLUMBER	23	\$ 763	741.98
INSTALL OUTSIDE AIR TEMPERATURE RESET ON HW HEATING	23 BUILDINGS FAMILY HOUSING HTG. PLANTS	1,051	7,207	95,976	1,046	PIPEFITTER	46	2,680	35.69
INSTALL TIME SWITCHES ON DHW CIRCULATORS	21 FAMILY HOUSING BUILDINGS	4,498	30,647	406,808	10,202	ELECTRICIAN	163	15,635	25.93
REMOVE UNNECESSARY LIGHT FIXTURES	28 BUILDINGS	2,895	19,381	213,384	-0-	ELECTRICIAN	731	22,134	9.64
INSTALL THERMOSTATIC RADATOR VALVES & 3-WAY VALVES	27 FAMILY HOUSING BUILDINGS	8,167	51,220	711,797	56,337	PIPEFITTER	579	76,892	9.22
REPAIR BROKEN WINDOW GLASS	37 BUILDINGS 11 FAMILY HOUSING INCLUDED	111	902	11,140	600	GLAZIER	37	1,552	7.18
REPAIR LEAKS IN BOILER PLANT PIPING	8 BUILDINGS	83	765	8,987	1,116	PLUMBER AND PLUMBER'S HELPER	12	1,668	5.39

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC FULDA

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10 <sup>6</sup> BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT		TOTAL COST (US \$)	SIR
					MATERIAL COST	TRADE	MANHOURS	
REPLACE SHOWER HEADS AND INSTALL LAVATORY INSERTS	27 FAMILY HOUSING BUILDINGS	3,797	\$27,748	349,411	\$51,730	PLUMBER	443	\$ 66,357
REPLACE INCANDESCENT WITH ENERGY-SAVING FLUORESCENT FIXTURES	45 BUILDINGS	845	13,904	135,740	12,638	ELECTRICIAN	413	26,450
INSTALL AUTO-CLOSING DEVICES ON EXTERIOR DOORS	54 BUILDINGS INCLUDING 18 FAMILY HOUSING	3,212	25,006	312,108	98,052	CARPENTER	109	100,935
REPAIR BADLY ALIGNED AND NONWORKING WINDOWS	54 BUILDINGS INCLUDING 6 FAMILY HOUSING	2,414	19,507	241,495	-0-	CARPENTER	2,533	83,581
INSTALL ROOF INSULATION IN FAMILY HOUSING FACILITIES	16 BUILDINGS	2,587	21,114	260,254	50,940	CARPENTERS	2,299	121,338
INSTALL LIGHTING CIRCUIT TIMERS	29 BUILDINGS	1,600	9,136	100,587	33,796	ELECTRICIAN	610	54,178

**TABLE A-5**

SUMMARY ENERGY CONSUMPTION BY END USE WITH  
CONSERVATION PROJECTS IMPLEMENTED: USMC FULDA<sup>1/</sup>

ENERGY USAGE CATEGORY	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)					TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	ELECTRICITY	
Space Heating	37,812	64,888	3,121	1,507	15,734	123,062
Domestic Hot Water	11,625	8,130	2,473	1,442	2,961	26,631
Process Consumption	-0-	2,356	3,879	240	62,351	68,826
Lighting-Inside	-0-	-0-	-0-	-0-	66,172	66,172
Lighting-Outside / Street	-0-	-0-	-0-	-0-	3,465	3,465
<b>TOTAL ENERGY USAGE FY82</b>	<b>49,437</b>	<b>75,374</b>	<b>9,473</b>	<b>3,189</b>	<b>150,683</b>	<b>288,156</b>

<sup>1/</sup> Leased housing and new facilities are not included. Energy savings include projects recommended by this EEAP study plus projects completed or programmed by the military community.

TABLE A-6

SUMMARY ENERGY CONSUMPTION BY FACILITY FUNCTION  
WITH CONSERVATION MEASURES IMPLEMENTED: USMC FULDA<sup>1/</sup>

BUILDING FUNCTION	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)					TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	ELECTRICITY	
Offices and Administration	10,228	6,210	-0-	773	11,080	28,291
Shops and Maintenance	3,318	26,098	-0-	-0-	20,909	50,325
Barracks and Quarters	19,508	7,466	6,447	2,416	35,764	71,601
Community Facilities	954	21,166	-0-	-0-	32,668	54,791
Dining Facilities and Clubs	-0-	4,977	382	-0-	14,318	19,677
Family Housing	15,420	9,454	2,644	-0-	32,478	60,005
Utilities - Street Lighting	-0-	-0-	-0-	-0-	3,466	3,466
<b>TOTAL ENERGY USAGE FY82</b>	<b>49,437</b>	<b>75,374</b>	<b>9,473</b>	<b>3,189</b>	<b>150,683</b>	<b>288,156</b>

<sup>1/</sup> Leased housing and new facilities are not included. Energy savings include projects recommended by this EEAP study plus projects completed or programmed by the military community.

PROJECTED UTILITY COSTS - USMC FULDA

ENERGY SOURCE	AVERAGE COST/MBTU IN DOLLARS (DM 2.40 = \$1.00) <sup>1/</sup>			
	ACTUAL FY82	PROJECTED FY85	PROJECTED FY90	PROJECTED FY95
Natural Gas	5.34	6.82	7.33	8.33
Liquid Propane Gas	7.52	9.61	10.33	11.73
No. 2 Fuel Oil	10.02	10.77	12.83	16.82
Coal	5.14 <sup>2/</sup>	6.14	6.70	6.90
Electricity	5.71	6.66	6.97	6.89

ENERGY CONVERSIONS:

Electricity . . . . .	11,600 Btu/kWh
Anthracite Coal (Stove & Nut) . .	$28.50 \times 10^6$ Btu/metric ton
Bituminous (High Vol) Coal . . .	$28.75 \times 10^6$ Btu/metric ton
No. 2 Fuel Oil . . . . .	136,582 Btu/gallon
Natural Gas . . . . .	3,413 Btu/kWh (11,207 kWh/m <sup>3</sup> )
Liquid Propane Gas . . . . .	95,000 Btu/gallon (4.43 lbs/gallon)

<sup>1/</sup> Based on DOE mid-term energy forecasts (commercial sector) for average of U.S. prices, exclusive of general inflation.

<sup>2/</sup> Consumption-weighted average of all coal types.

**SUMMARY OF ECIP PROJECT DATA FOR USMC FULDA**

PROJECT TITLE	ENERGY SAVINGS (10 <sup>6</sup> BTU/YEAR)	ANNUAL COST SAVINGS (DOLLARS)	TOTAL REQUEST FY 87 (\$1,000)	SAVINGS-TO-INVESTMENT RATIO	REFERENCE SECTION (VOL. 1)
ECIP: DOMESTIC HOT WATER HEATING ENERGY CONVERSATION	32,282	216,492	265.2	12.28	10.3.3
ECIP: HEATING PLANT PIPING INSULATION AND WASTE HEAT RECOVERY	54,355	489,571	681.9	11.12	10.3.1
ECIP: BUILDING HEATING CONTROLS UPGRADE	31,288	265,257	494.7	8.47	10.3.4
ECIP: WEATHERIZE MCA FACILITIES	15,097	140,206	651.1	3.27	10.3.5
ECIP: BOILER PLANT UPGRADE FOR FAMILY HOUSING	21,248	99,830	956.4	2.17	10.3.2

**TABLE A-9**

SUMMARY OF FACILITIES ENERGY CONSUMPTION - USMC FULDA<sup>1/</sup>

PARAMETER	FY75 <sup>2/</sup>	FY80	FY81	FY82	FY85
Total Energy Usage ( $10^6$ BTU) <sup>3/</sup>	476,800	523,981	546,646	552,601	337,215
Active Facility Area ( $10^3$ SF)	2,465	2,885	2,804	3,026	3,265
Energy Use/SF ( $10^3$ BTU/SF)	193	182	195	183	103.3
Percent Increase (Decrease) <sup>4/</sup>	--	(5.7)	1.0	(5.2)	(46.5)

1/ Includes estimates of energy savings from facility funded projects and those recommended in this document plus planned new construction.

2/ Includes leased housing, since breakdown not available.

3/ Represents actual consumption converted to BTU's using the ECIP Guidance.

4/ Percent increase (decrease) based on FY75 value and usages per square foot.

TABLE A-10

TYPICAL BUILDING ENERGY CONSUMPTION  
USMC FULDA

FUNCTION	BUILDING NO.	GY AREA	FY 82 ESTIMATED ENERGY CONSUMPTION (MBTU)				GROSS S.F.	KBTU/SF PER YEAR
			LIGHTING	SPACE HEATING	DHW HEATING	PROCESS		
Administration	8000	406	825	2,801	76	1,721	5,423	34,460
Dining	7109	249	341	1,896	885	475	3,597	17,093
Shop	7111	249	2,845	19,254	57	72	22,228	44,723
Barracks	7219	249	859	6,894	2,225	49	10,027	56,531
Gymnasium	7211	249	574	1,233	447	15	2,269	12,115
Family Housing	7301	733	353	2,607	1,005	1,172	5,137	34,862

TABLE A-11